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ABSTRACT

A sample of 48 second grade and fifth grade children, containing equal numbers of high and low ability readers, participated in a study that explored the degree to which oral and silent reading represented the same cognitive process for different age and ability level children. Their reading rates and comprehension scores for both oral and silent reading were compared for text that varied in terms of decodability (regularity of phonic patterns), word frequency, syllables in words, and semantic difficulty of sentences. The results suggested that oral reading and silent reading represent a similar cognitive process. However, there was evidence that readers decreased their processing time on difficult words in silent as compared to oral reading. This tendency was pronounced for poor readers. (Author/FL)

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Comparison of Processing Strategies in Oral and Silent Reading by Good and Poor Readers

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Running Head: Oral/Silent

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The relationship between oral and silent reading is not clear. Oral reading is the more easily observed mode and, therefore, has been the window through which researchers have commonly viewed the reading process. Insights gleaned through such studies are often applied to silent reading even though such generalizations may be inappropriate.

Several researchers suggest that oral and silent reading may be distinct processes (e.g., Judd, 1918; Buswell, 1937; Cole, 1938; Wanat, 1971; Mosenthal, 1976-77). Such researchers emphasize differences in eye movements, reading speeds, and differing profiles for comprehension errors. Other researchers believe oral and silent reading stem from the same basic cognitive process (Anderson & Dearborn, 1952; Rogers, 1937; Swanson, 1937). These researchers emphasize the similarities in skill development that readers demonstrate for both modes. Differences in eye movements and reading speed are considered as relatively superficial differences due to the overt vocalization of oral reading. (For a good literature review of oral and silent reading see Levin, 1979.)

At least three major theories of word identification have been proposed and applied to both oral and silent reading. One theory suggests that access to lexical meaning is mediated by a phonological recoding stage where individual letters or letter clusters are processed into "sound" using stored letter-sound correspondences (Gough, 1972). Another theory suggests that access to the lexicon is mediated only by visual processing of individual letters via spelling patterns and orthographic redundancies (Massaro, 1975).

A third theory suggests that access to the lexicon is not mediated through recognition of individual letter sequences but involves direct template matching or matching of criterial feature sets of words (Smith, 1971).

It is not clear if any of these hypotheses is correct, nor if word identification is achieved by more than one type of processing. High frequency words may be recognized through nonmediated methods while low frequency words are mediated, or several types of processing may occur in parallel. It is also not clear whether oral and silent reading evoke identical word identification processes. While phonological recoding may be used in oral reading, it may not be in silent reading. Or if lexical access is mediated by visual features, such access may secure only meaning information in silent reading but meaning information plus phonological representations in oral reading. Further, if silent reading involves less phonological and/or visual analysis than oral reading, then during silent reading there may be a greater allocation of processing time for text comprehension.

The basic research question we explored was the degree to which oral and silent reading represent the same cognitive process for different age and ability level elementary school children. By "same process" we mean that the only difference between the 2 modes is the overt vocalization of oral reading; while silent reading involves an equivalent type of processing, such as subvocalization. Thus, if there is mediated processing in reading, then we would expect the same degree of mediation of visual and/or phonological patterns in both modes. We would also expect the same degree of processing for meaning.

In the study subjects read sentences composed of words that varied on

dimensions which were expected to reflect depth of decoding and meaning activities. The basic assumption was that factors which affect reading time and comprehension in oral reading should similarly affect rate and comprehension in silent reading--if the two modes represent the same process.

Two factors which affect the internal structure of words were used to reflect depth of mediated decoding. The first factor was decodability, the regularity of phonic patterns in words. Words were selected with letters that represented either common, regular pronunciations and phonic patterns (C$\breve{V}$C, C$\bar{V}$CE, C$\bar{V}$) or uncommon, irregular letter-sound patterns. The influence of letter-sound patterns on oral pronunciation has been indicated (Calfee, Venezky, & Chapman, 1969). If the same type of decoding occurs in silent reading as in oral reading, we should expect similar effects of this factor on the reading times and comprehension scores in the two modes. Likewise, number of syllables (one or two) was a factor as there is some evidence that syllables, or a close approximation to them, form a basic unit in decoding (Gibson, Pick, Osser, & Hammond, 1962; Gibson, Bishop, Schiff, & Smith, 1964; Coke, 1974; Spoehr & Smith, 1973, 1975). Even if the syllable is not a basic decoding unit, it varies the length of the word. If there is mediated analysis of letter groups, word length should affect the decoding process. Again, number of syllables should equally affect reading times and comprehension scores in both modes if they are reflections of the same cognitive process.

Two factors associated with ease of achieving meaning for sentences were also included. These factors were concreteness and reversibility. Sentences were composed of either concrete or abstract nouns. Evidence

exists that concrete words cause considerably fewer comprehension errors than abstract words (Paivio, 1969; Mason, 1977). If allocation of processing time for meaning is greater in silent than in oral reading, then an interaction between mode of reading and concreteness should occur. That is, abstract words which are typically more difficult to comprehend should cause greater comprehension errors and slower reading rates in oral than in silent reading. The other factor expected to influence meaning processing was reversibility (whether the subject and object of a sentence are semantically interchangeable). For example, in the sentence, "The cub sees the dog," "cub" and "dog" can be interchanged and still create an acceptable sentence. This acceptable interchange is not possible in a nonreversible sentence such as "The owl sees the field." Reversible sentences have been shown to require longer processing and to cause more comprehension errors than nonreversible sentences (Slobin, 1966; Turner & Rommetveit, 1967; Bever, 1970). As with concreteness, reversibility should affect rate and comprehension errors more in oral than in silent reading if there is greater attention to meaning in silent reading. However, the impact of reversibility and concreteness should be the same in oral and silent reading if they are equivalent processes.

In addition to these four variables, a word frequency factor was included. This factor was meant to reflect any processing differences that might occur between common and uncommon words. Some studies have suggested that uncommon words require more mediated processing than common words (Perfetti & Hogaboam, 1975; Jorm, 1977; Juel & Solso, in press). Likewise, Juel (1979) found that children were more likely to achieve meaning for sentences with common words than with rare words. A summary of the hypotheses

appear in Table 1.

Insert Table 1 about here

Finally we were concerned that good and poor readers may differ in their approaches to oral and silent reading as indicated by Anderson and Swanson (1937) and Guthrie and Tyler (1976). Hence, grade level and ability differences were examined.

Method

Subjects

A total of 48 subjects participated in the study. Equal numbers of second and fifth graders of high and low ability were selected from a college sponsored summer reading program. Subjects were classified as high ability if they scored 6 months to 2 years above their grade level on both the word recognition subtest of the WRAT and on an informal reading inventory. Subjects were classified as low ability if they scored 6 months to 2 years below grade level on the same two measures. In addition, only subjects falling within a normal range on the Peabody Picture Vocabulary Test (high ability $\overline{X}$ = 107; low ability $\overline{X}$ = 100) were selected.

Materials

Sixty-four sentences were constructed that followed a subject-action-object (SAO) sequence. These sentences were divided into 2 comparable sets (A and B) of 32 sentences each. The subject and object of each sentence were nouns of equivalent levels of frequency, decodability, concreteness, and number of syllables. In addition, half of the sentences were reversible and half were non-reversible. The reversible sentences contained an interchangeable subject and object. There were two levels of each of the word factors. Frequency was determined by the total word frequency count of

Carroll, Davies, and Richman (1971). The mean frequency for high frequency words was 521.3 per five million, with a range from 53 to 5486 per five million. The mean frequency for low frequency words was 19.2 per five million, with a range from 0 to 48 per five million. Decodability was determined by how closely the word corresponded to phonic generalizations (i.e., $C\breve{V}C$, $C\bar{V}$, $C\bar{V}CE$). Easy decodable words had only one vowel or one vowel plus a silent "e" per syllable and corresponded to the generalizations. Hard decodable words had at least one syllable which contained vowel patterns not corresponding to the generalizations. Concreteness was determined by combining the criteria suggested by Gorman (1961); Paivio (1965); Spreen and Schultz (1966) and Paivio, Yuille, and Madigan (1968). Two major criteria for concrete words emerged: (1) direct reference to sense experience; and (2) specificity of referent class (the similarity of class exemplars). Using these criteria, four adults independently rated potential experimental words as concrete or abstract. Words rated unanimously by all four judges to be either clearly concrete or abstract were included in the study. The verbs in the sentences came from the Harris-Jacobson Core Word Lists for First Grade (1972).

Sentences shown to the subjects were typed on 4 inch by 5 inch (10 X 15 cm) unlined cards. In the comprehension task, subjects were shown four black and white schematic drawings pasted side by side on a cardboard strip. Individual pictures measured 2 3/4 by 3 1/2 inches (7 X 9 cm). For each sentence, four pictures were given: the correct one, two pictures with one incorrect element; and one picture with two incorrect items. Serial order of the correct picture was randomized through the picture sets. Sample sentences are shown in Table 2 and sample pictures in Table 3.

Insert Table 2 and Table 3 about here

Design

The within-subjects portion of the design was a 2^6. Factors included four word factors, one sentence factor, and one mode of reading factor. The word factors were (1) frequency (high or low); (2) decodability (easy or hard); (3) concreteness (concrete or abstract); and (4) number of syllables (one or two). The sentence factor was reversibility (reversible or non-reversible). The mode of reading factor was oral or silent. Sentences in the 2^6 design were divided into two balanced sets to create a between-subjects blocking factor in order that subjects would not read any sentence in both the oral and silent modes. The between-subjects factors were grade level (second or fifth), reading ability (good or poor), and block (one or two). Thus, the entire design was a $2^3 \times 2^6$ factorial.

Procedure

Each subject was initially screened to verify ability to identify the first grade level verbs. Those subjects unable to identify these words were not included as subjects.

Subjects were tested individually in a single session lasting approximately thirty minutes. Subjects in Block 1 read Set A sentences orally and Set B sentences silently. Block 2 subjects read Set A sentences silently and B sentences orally. Order of presentation of the sets was random. For both modes cards containing the individual sentences were placed face down in a stack before the subject. The subject was to pick up the card, read it, look up at the experimenter when reading was completed, and place the card face down in another stack. Timing began when the subjects focused on the print and ended when the subject cued the experimenter by

looking up, that reading was completed. Several practice trials were given until the subjects' responses were automatic. Reading rate was calculated by use of an electronic stopwatch to the nearest one hundredth of a second accuracy. Subjects were instructed that no help in word identification would be given.

Following the reading of each sentence, the subject was shown the comprehension task card with the four picture choices. The instructions were to point to the picture which best represented the meaning of the sentence. Comprehension was determined by the subject's choice of an incorrect or correct picture representing the meaning of the sentence.

Analysis of the Data

The data were analyzed by repeated measures analysis of variance performed separately for the sentences read orally and those read silently. Interactions between reading mode, grade, ability, and the five word and sentence factors were measured by select comparisons. Block was not found to be significant in any of the analyses and was not included as a factor in the analyses reported in this paper. The dependent variables were reading time and comprehension errors. The significance level for all analyses was set at .05.

Results and Discussion

Reading Time

It was predicted that if oral and silent reading represent the same cognitive process, then reading time should be very similar between the two modes. Analysis of the select comparisons indicated that while there was a significant main effect of mode on reading time, $F = 38.1$, $p < .01$, (Mean RT Oral Reading = 5.334 seconds; Mean RT Silent Reading = 4.017 seconds), there

were significant interactions between grade and mode, $F = 12.8$, $p < .01$, (Figure 1), and ability and mode, $F = 32.4$, $p < .01$, (Figure 2). As seen in Figure 2 the "same process" hypothesis holds for good but not for poor readers. Likewise the hypothesis fits older better than younger readers (Figure 1).

Insert Figure 1 and Figure 2 about here

The second prediction was that there should be similar effects of decodability, syllables, frequency, concreteness, and reversibility on reading times in the two modes. Means and results of the analysis of variance of main effects appear in Table 4. As seen in Table 4 all the word and sentence factors significantly affected reading times in both modes. Further, mean reading times for the different levels of each factor reveal similar patterns in the two modes. (It might be noted that reversibility has the same effect in both modes, though inexplicably not in the predicted direction.) However, the magnitude of the syllable, decodability, frequency, and concreteness effects were considerably less in silent than in oral reading--as indicated by the significant interactions of these factors with reading mode (Mode x Syllables, $F = 34.7$, $p < .01$; Mode x Decodability, $F = 39.9$, $p < .01$; Mode x Frequency, $F = 32.5$, $p < .01$; Mode x Concreteness, $F = 15.5$, $p < .01$).

Insert Table 4 about here

Decodability and syllables, the two factors most associated with mediated models and the factors most likely to reflect the degree of mediated decoding, had proportionally stronger effects on oral than on silent reading. However, the direction of effects is the same: sentences

with one syllable or easy decodable words evoke faster reading times than sentences with two syllable or hard decodable words (Table 4). It appears that word identification in both modes is mediated by either phonological or visual analysis of spelling patterns, etc. The difference in magnitude in the effects of syllables and decodability (as well as frequency and concreteness) seems to be due to the tendency for all readers to decrease processing time on difficult words in silent as compared to oral reading (e.g., on hard decodable words; Table 4). This tendency is particularly striking for poor readers as indicated by several significant interactions: ability and mode (Figure 2), and ability and mode with decodability (Figure 3: $F = 10.8$, $p < .01$), syllables (Figure 4: $F = 12.1$, $p < .01$), frequency (Figure 5: $F = 7.7$, $p < .01$), and concreteness (Figure 6: $F = 6.9$, $p < .05$).

Insert Figures 3, 4, 5, and 6 about here

There appears to be great similarity between what good readers do in oral and in silent reading. Reading times in both modes, for all word types, are about the same. Good readers appear to identify words in both modes using the same type of mediated processing of phonological and/or visual patterns (Figures 3 and 4). They appear to spend about the same time identifying common and uncommon words in both modes (Figure 5). They also appear to spend equivalent processing time on meaning in both modes, as indicated by the effects of frequency and concreteness (Figures 5 and 6). Poor readers, on the other hand, show very dissimilar reading times and dissimilar effects of decodability, syllables, frequency, and concreteness in the two modes. Words with difficult internal patterns (e.g., two syllable and hard decodable words) or words which are unlikely to be "sight" words (e.g., low frequency words), greatly increase poor readers' processing times in oral, but not in

silent, reading. In silent reading such readers appear to dramatically decrease mediated prccessing. Our findings and interpretation parallel those of Guthrie and Tyler (1976) who found indications of incomplete decoding during silent reading by poor readers. Likewise, poor readers do not appear to spend equivalent time on processing for meaning in both modes as indicated by less time spent on low frequency and abstract sentences in silent reading (Figures 5 and 6). However, low frequency words are also less likely to be sight words. Since achieving sound representations for words is critical for oral reading, it may be that poor readers are forced to spend more time trying to identify low frequency words in oral reading. Poor readers may try to achieve the necessary word identifications for oral reading by using context (Juel, 1980). Utilization of context appears easier in concrete and high frequency sentences. Such an interpretation is consistent with the data (Figures 5 and 6).

Comprehension

Our third hypothesis was that if oral and silent reading represent the same process, then the number of comprehension errors should be very similar between the two modes. Indeed, this was the case. There were 26 percent errors in oral reading compared to 29 percent errors in silent reading--not a statistically significant difference. We might have expected poor readers to have made significantly more errors in silent over oral reading, if they incompletely decode words in this mode. This did not occur. Means and results of the analysis of variance for main effects are shown in Table 5. We believe poor readers spend more time trying to decode words in oral reading, as achieving sound equivalents for words is central to this mode. But though they "try harder" in oral reading, they either are no more

successful than in silent reading or the time spent on achieving a successful decoding interferes with comprehension to the same degree as not achieving a successful decoding.

Insert Table 5 about here

Our fourth hypothesis was that if oral and silent reading represent the same process there should be similar effects of decodability, syllables, frequency, concreteness, and reversibility on comprehension errors in the two modes. Again, this hypothesis was supported as there were no significant interactions between mode and any factor on comprehension errors. The same factors that caused errors in oral reading caused errors in silent reading (Table 5). In particular, concreteness, frequency, and decodability had significant main effects on comprehension errors in both modes. The decodability effect again points to mediated processing in both modes. Unless words are visually and/or phonologically decoded before lexical access, we have little reason for such an effect (i.e., phonic regularities would not serve to deter access to meaning).

Reversibility did not have a significant main effect on comprehension errors. However, it interacted with other factors. The decodability by frequency by reversibility interaction appears in Figure 7. Children have no trouble with reversible sentences which contain easy decodable, high frequency nouns. There is an indication that reversibility affects comprehension when more attention must be given to word recognition and lexical access--as in sentences with hard decodable or low frequency nouns. In any case, the reversibility effects are the same for both reading modes.

Insert Figure 7 about here

Conclusions

Results of the current study support similar reading models for oral and silent reading. Both processes appear to involve mediated processing prior to lexical access. The exact nature of this mediation, whether and to what degree it involves phonological or visual analysis, was not determined.

It does appear, however, that readers decrease processing time on difficult words in silent as compared to oral reading. Poor readers, in particular, seemed to decode less in silent than in oral reading.

Footnotes

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Table 1

Summary of Hypotheses

If oral and silent reading represent the same process:	If oral and silent reading represent different processes
1) Reading times should be very similar between the two modes.	1) Reading times should be dissimilar between the two modes.
2) There should be similar effects of decodability, syllables, frequency, concreteness, and reversibility on reading times in the two modes.	2) There should be dissimilar effects of decodability, syllables, concreteness, and reversibility on reading times in the two modes.
3) Number of comprehension errors should be very similar between the two modes.	3) Number of comprehension errors should be dissimilar between the two modes.
4) There should be similar effects of decodability, syllables, frequency, concreteness, and reversibility on comprehension errors in the two modes.	4) There should be dissimilar effects of decodability, syllables, frequency, concreteness, and reversibility on comprehension errors in the two modes.

Table 2

Sample Sentences

The bus hits the car. (one syllable, easy, concrete, high frequency, reversible)

The tiger sees the rabbit. (two syllables, easy, concrete, high frequency, reversible)

The crown has a pearl. (one syllable, hard, concrete, high frequency, non-reversible)

Her glamour starts envy. (two syllable, hard, abstract, low frequency, non-reversible)

The wife hugs her mate. (one syllable, easy, abstract, high frequency, reversible)

The youngster does the laundry. (two syllables, hard, concrete, low frequency, nonreversible)

Table 3

Sample Pictures

The bus hits the car.

The bum hits the bag.

The cow finds the mouse.

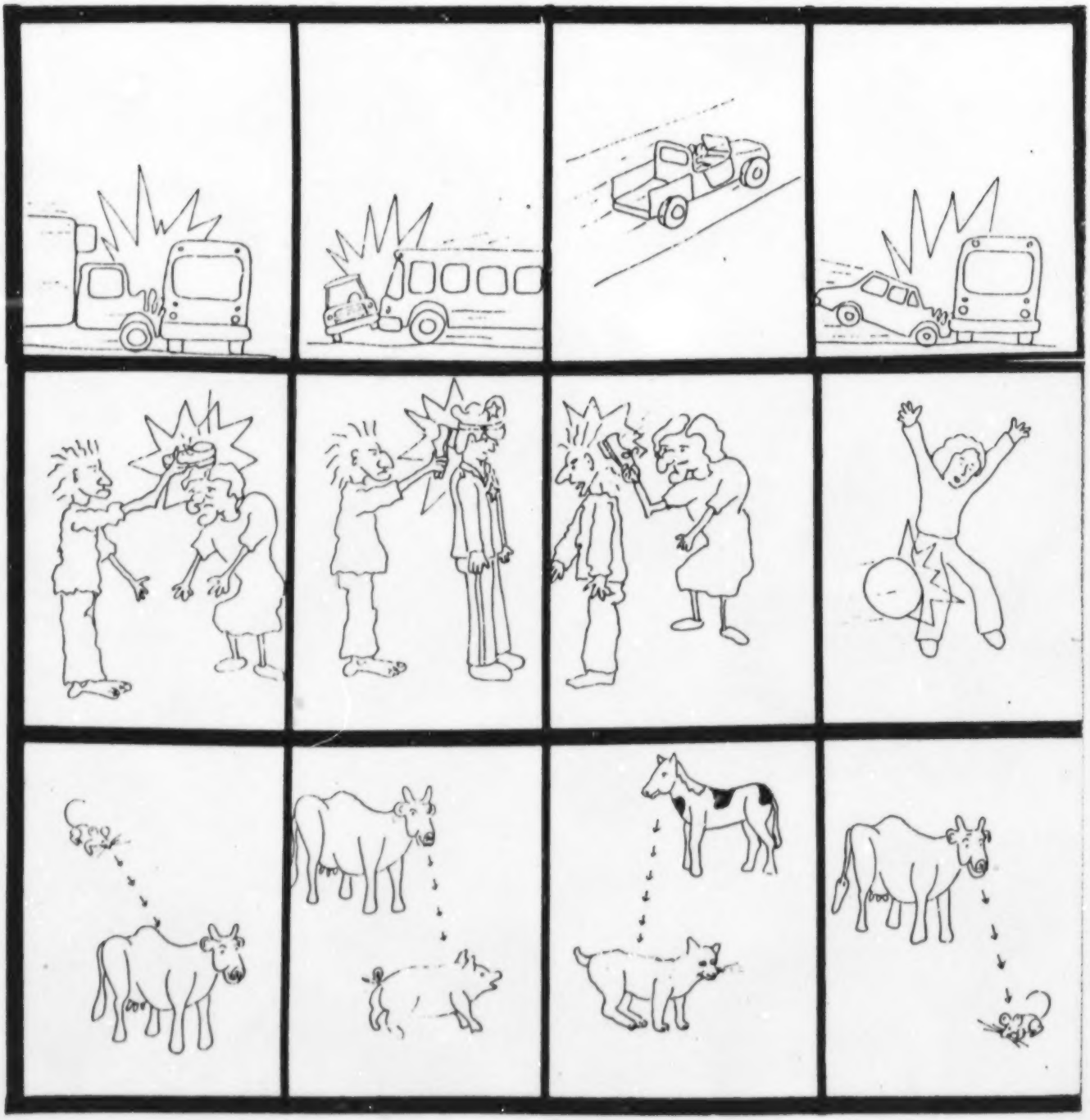

Table 4

Means and Analysis of Variance
of Main Effects on Reading Times

Source	Oral Reading F	Oral Reading (Error)	Oral Reading Means[a]	Silent Reading F	Silent Reading (Error)	Silent Reading Means[a]
Grade	6.1*	(161.49)		.0	(65.55)	
Two			6.134			4.053
Five			4.573			3.981
Ability	39.0**	(161.49)		15.4**	(65.55)	
Good			3.308			3.206
Poor			7.359			4.828
Decodability	63.0**	(24.02)		8.5**	(5.15)	
Easy			4.341			3.848
Hard			6.236			4.186
Syllables	60.3**	(27.74)		15.5**	(3.63)	
One			4.290			3.826
Two			6.377			4.209
Frequency	69.8**	(24.57)		30.7**	(5.59)	
High			4.413			3.683
Low			6.254			4.352
Concreteness	42.6**	(24.57)		32.9**	(4.67)	
Concrete			4.508			3.701
Abstract			6.159			4.333
Reversibility	13.5**	(14.12)		9.6**	(4.50)	
Non-reversible			5.686			4.185
Reversible			4.981			3.850

[a] Mean seconds reading time
** $F(1,44) = 7.24$, $p < .01$
* $F(1,44) = 4.06$, $p < .05$

Table 5

Means and Analysis of Variance
of Main Effects on Reading Comprehension Errors

Source	Oral Reading F	(Error)	Means[a]	Silent Reading F	(Error)	Means[a]
Grade	17.7**	(.383)		28.5**	(.380)	
Two			.323			.372
Five			.190			.204
Ability	34.3**	(.383)		30.3**	(.380)	
Good			.164			.202
Poor			.349			.375
Decodability	28.3**	(.155)		15.6**	(.188)	
Easy			.203			.245
Hard			.310			.332
Syllables	.1	(.083)		.7	(.209)	
One			.259			.298
Two			.254			.279
Frequency	49.3**	(.172)		50.8**	(.220)	
High			.182			.203
Low			.331			.374
Concreteness	31.5**	(.250)		26.4**	(.213)	
Concrete			.185			.228
Abstract			.328			.349
Reversibility	.7	(.187)		1.4	(.133)	
Non-reversible			.247			.277
Reversible			.266			.300

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[a] Mean percent comprehension errors
** $F(1,44) = 7.24$, $p < .01$
* $F(1,44) = 4.06$, $p < .05$

Figure Captions

Figure 1 - Grade by mode interaction

Figure 2 - Ability by mode interaction

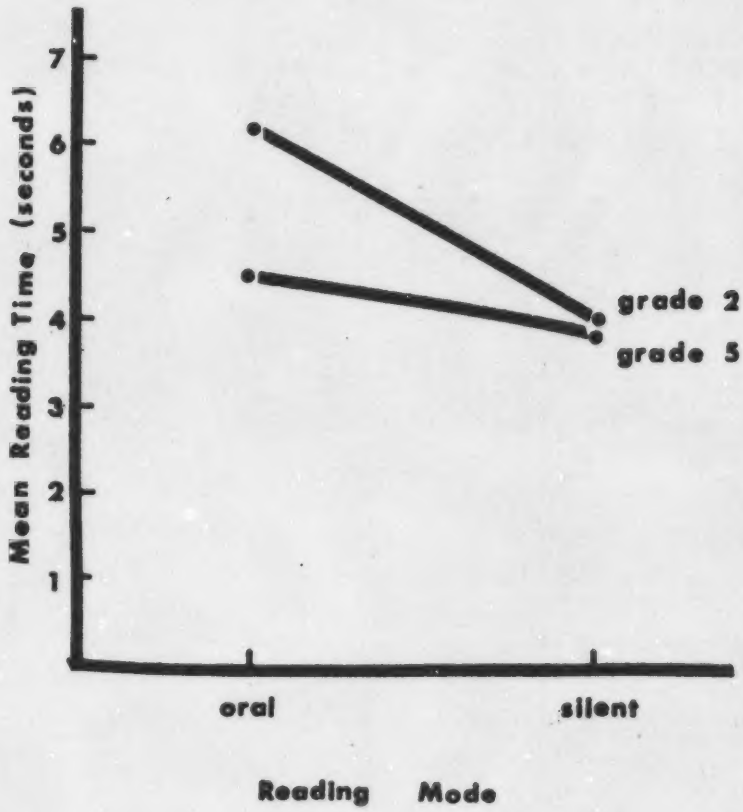
Figure 3 - Ability by decodability by mode interaction

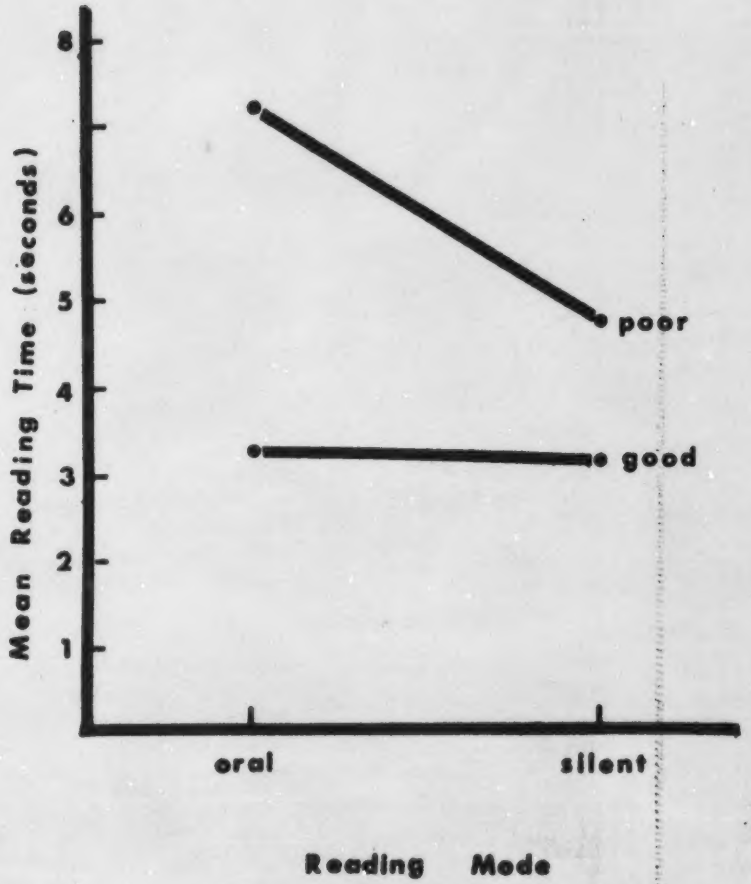
Figure 4 - Ability by syllables by mode interaction

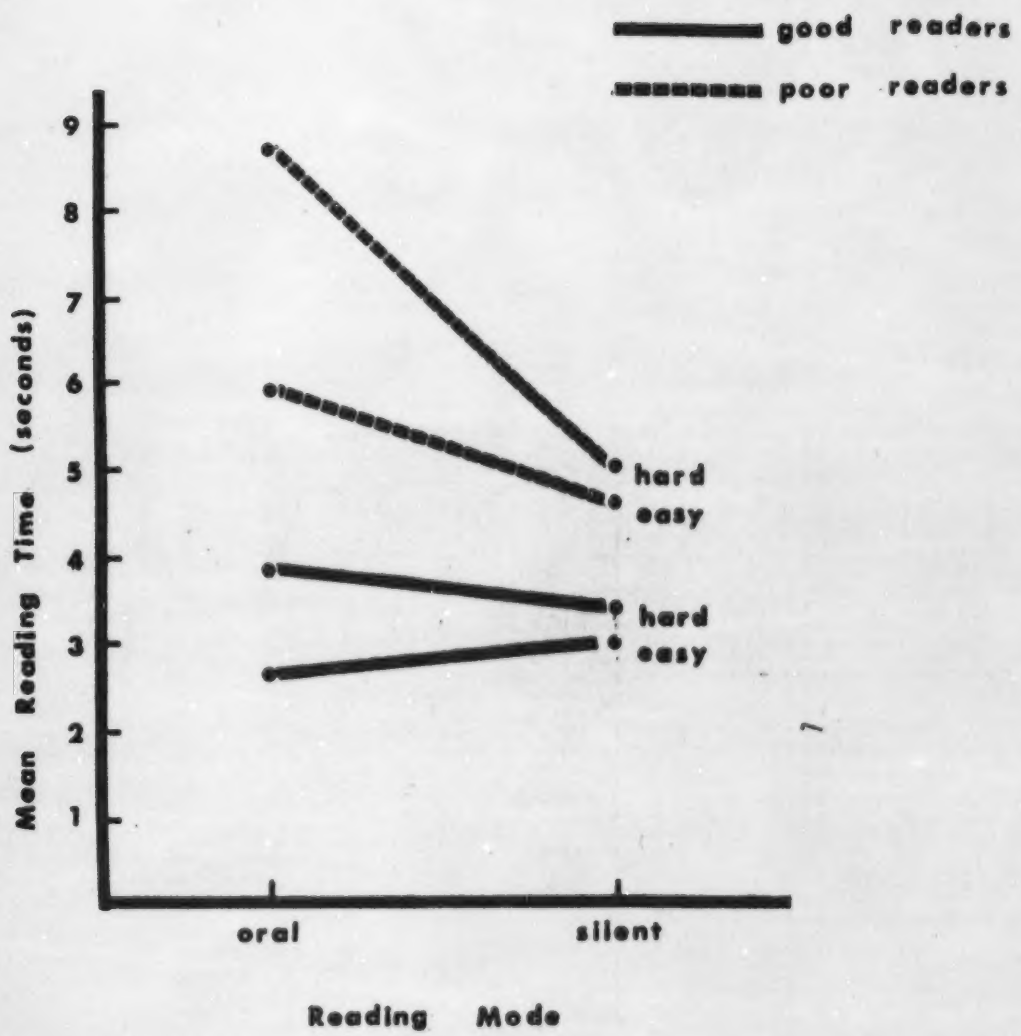
Figure 5 - Ability by frequency by mode interaction

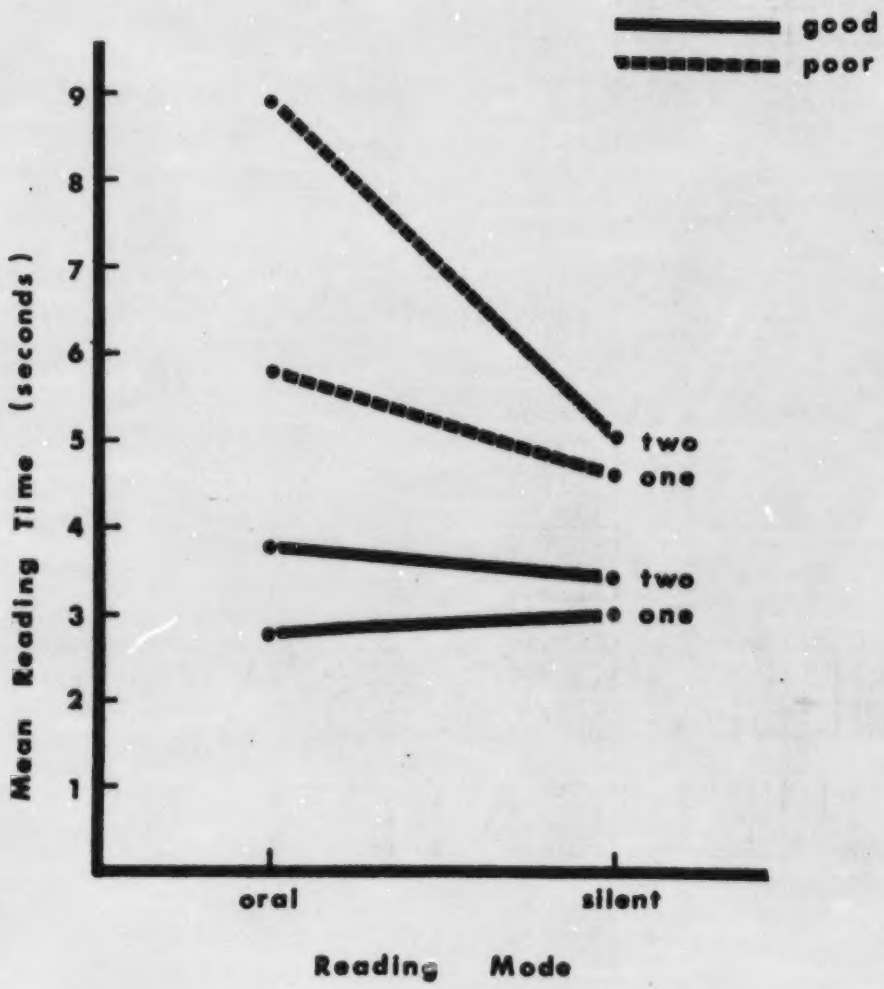
Figure 6 - Ability by concreteness by mode interaction

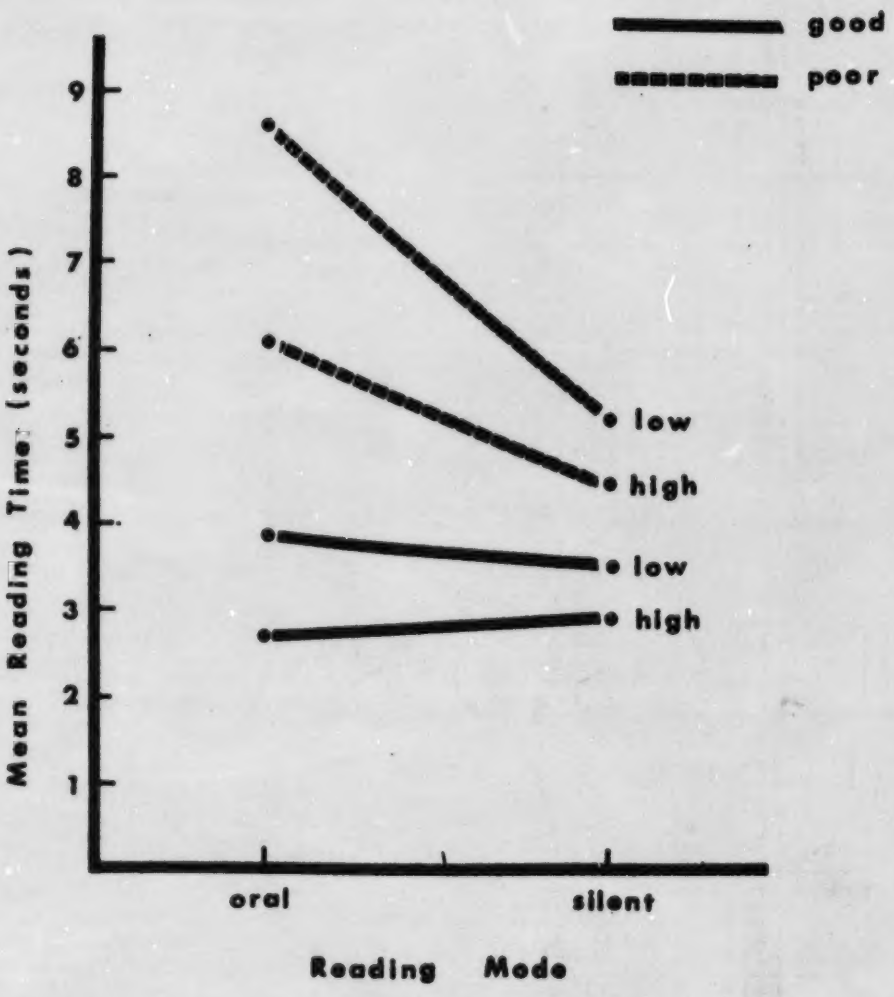
Figure 7 - Frequency by decodability by reversibility for oral and silent reading

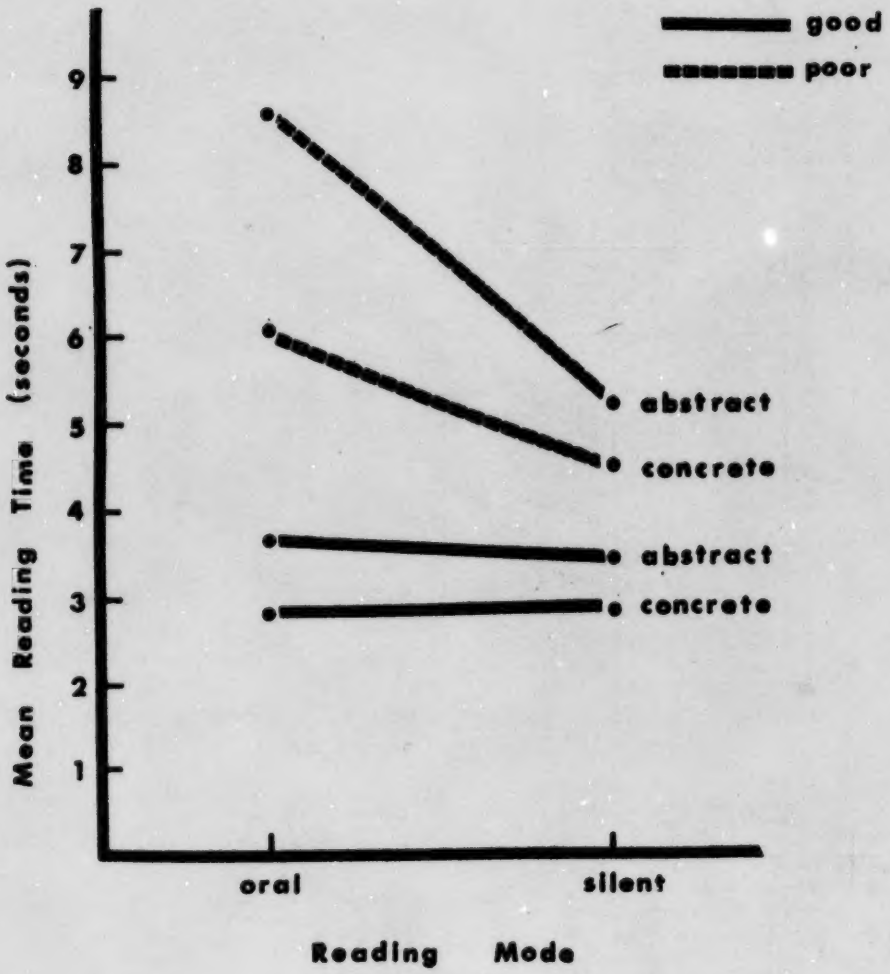

Mean Reading Time (seconds)
7
6
5
4
3
2
1
grade 2
grade 5
oral
silent
Reading Mode

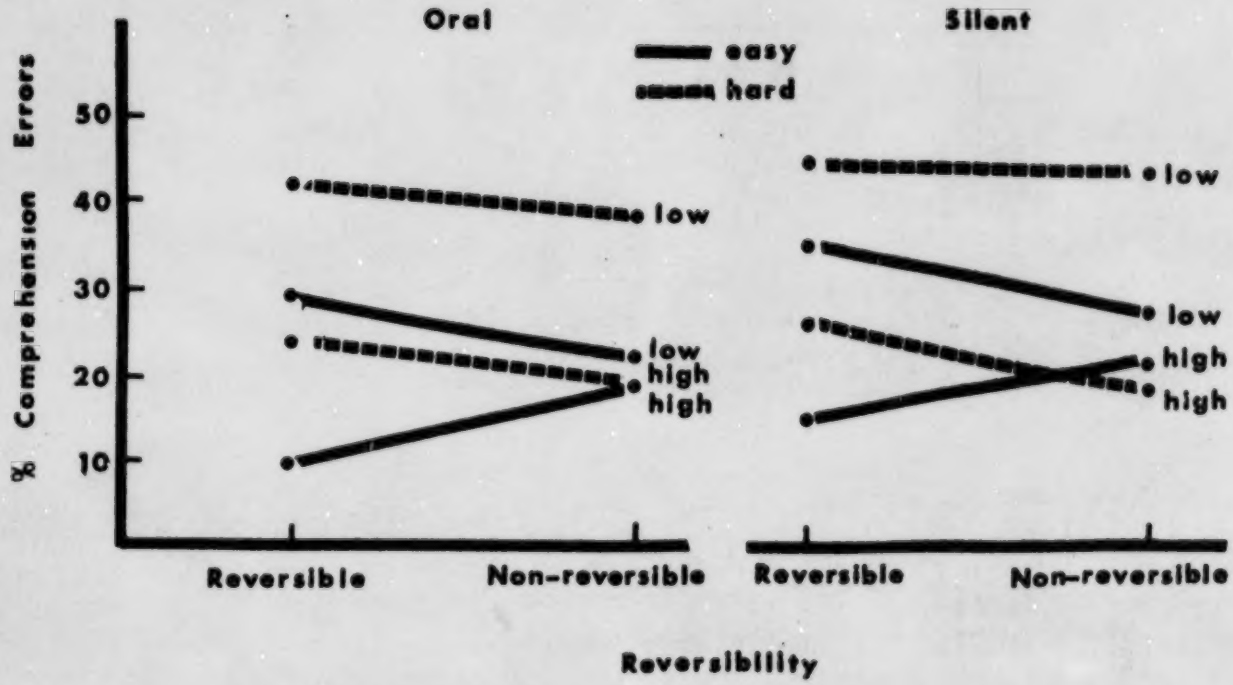

Mean Reading Time (seconds)
8
6
5
4
3
2
1
poor
good
oral
silent
Reading Mode


good readers
poor readers
Mean Reading Time (seconds)
9
8
7
6
5
4
3
2
1
hard
easy
hard
easy
oral
silent
Reading Mode


good
poor
Mean Reading Time (seconds)
9
8
7
6
5
4
3
2
1
two
one
two
one
oral
silent
Reading Mode


good
poor
9
8
7
6
5
4
3
2
1
Mean Reading Time (seconds)
low
high
low
high
oral
silent
Reading Mode


good
poor
9
8
7
6
5
4
3
2
1
Mean Reading Time (seconds)
abstract
concrete
abstract
concrete
oral
silent
Reading Mode


Oral
Silent
easy
hard
% Comprehension Errors
50
40
30
20
10
low
low
high
high
low
low
high
high
Reversible
Non-reversible
Reversible
Non-reversible
Reversibility